The effect of defined benefit pension plans on measurement of the cost of capital for UK regulated companies

A report for Ofcom

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SUMMARY

In this report for Ofcom I examine whether there is a robust way to make an adjustment for the presence of defined benefit ("DB") pension plan when estimating the cost of capital for regulated UK companies.

In the academic finance literature, there is a simple formula for this adjustment, first proposed by Jin, Merton, and Bodie ("JMB"). The logic of the formula is that for a firm with a large DB plan a lot of the observed equity risk could emanate from the pension plan. In that case, the measured equity beta will reflect much more than the "pure" asset beta of the operating business. The observed beta should be reduced before being used as the basis for the cost of capital of the operating business.

The JMB formula for the size of the adjustment depends on two things:

- The <u>gross</u> value of the pension fund relative to the value of the firm's operating business.
- The difference between the betas of the assets and liabilities of the pension plan.

Using this formula, the size of the adjustment for companies with significant DB plans can be very large. In other words, the estimated "pure" operating asset beta can be much lower than the observed conventional asset beta. In particular, if this type of adjustment were applied to some regulated UK firms, it would have a significant impact on allowable returns.

Because the potential size of the adjustment is so large, I investigate the robustness of the approach in two ways. I examine the assumptions of the procedure and the degree to which they are supported by the literature. I also attempt to apply the procedure to a sample of regulated UK companies chosen by Ofcom.

The literature review reveals several important shortcomings of the JMB formula. In particular, it requires estimates of:

- The degree to which credit risk of the firm is passed to pensioners;
- The way in which the pension plan affects the operating costs, wage-bargaining, and other features of the operating strategy of the firm;
- The degree to which the tax system absorbs part of the pension risk;

- The way that the value of pension liabilities responds to changes in the stock market via, for instance, changed expectations about real wage growth;
- How to reflect their very long duration in the estimated beta of pension liabilities;
- How to include in the adjustment the possibility that regulation will operate to pass part of the pension risk to customers;
- How to allow for possibility that the short-term share price fluctuations, on which measured betas are based, may not immediately and fully reflect the short-term fluctuations in the pension plan.

There is no definitive conclusion regarding any of these in the literature. All of them give rise to significant measurement problems.

To give the analysis substance in the UK regulatory context I apply the analysis to seven regulated UK companies selected by Ofcom which have large DB pension plans. I investigate whether there is a robust way of adjusting their asset betas for the presence of these pension plans. I find that the difficulties listed above are, in fact, material for these companies. There is no robust way of making a quantitative adjustment to the cost of capital for the presence of the DB pension fund for these companies.

I do find that the direction of the adjustment is probably downwards, but its size is indeterminate. I also find that the effects listed above generally make the size of the adjustment much smaller than a naïve application of the JMB method would imply. In particular, the most naïve version of the JMB method gives implausibly low estimates of the cost of capital for firms with very large DB plans.

In summary, therefore, there is in my opinion no robust procedure which can be used to reliably estimate the size of the adjustment which should be made to the cost of capital for a DB pension plan. Any adjustment would, in my opinion, be subjective and a matter of regulatory judgement.

In my opinion, for an industry with companies that do not have DB plans the simplest way of estimating a "pure" operating asset beta is to use those companies and not to attempt to make adjustments to the cost of capital of firms with large DB plans. Where a regulated company is unique, this is not an option and all the above difficulties apply.

1. Introduction

UK regulators often use the cost of capital of regulated firms as an input to the regulatory process. Cost of capital estimates are typically based on the weighted average costs of the debt and equity of regulated firms. Some regulated firms have large defined benefit ("DB") pension plans. For these firms the observed cost of capital reflects the risks of both their operating businesses and their pension plans. In such cases the regulator may wish to know the cost of capital of the operating business separated from any risk emanating from the pension plan.

Estimating the cost of capital for a firm stripped of the risk of its DB pension plan (the "pure" operating asset beta) is a complex task. It involves:

- Measuring the systematic risks of the assets and liabilities of the DB plan;
- Deciding how the risk of the assets and liabilities of the DB plan combine to generate systematic risk for the net value of the plan;
- Deciding how the net systematic risk emanating from the pension plan is reflected in the observed equity prices of the firm, on which the firm's observed cost of capital is based;
- Deciding how the observed cost of capital should be adjusted to eliminate the impact of the net risk emanating from the pension plan.

Even if this can be done and a "pure" operating asset beta is estimated, the resulting number must be used with care. A cost of capital based on this number must be applied to cash flows and asset values which are consistent with the application of a "pure" operating asset cost of capital.

In this report for Ofcom I examine whether adjustments for the presence of DB pension plans should be made when estimating the cost of capital for regulated UK companies. As I show in the next Section, using one standard approach the size of the adjustment for companies with significant DB plans can be large. The logic is that if a lot of the observed equity risk is emanating from the pension plan, then the "pure" operating asset risk must be lower than the observed asset beta. If this type of adjustment were applied in UK regulation it would have a significant impact on allowable returns. Therefore, in the remainder of the report I investigate the robustness of the approach and its practicality for application to regulated UK companies. The structure of the report is as follows. In Section 2 I summarise the standard analysis of the effect of a DB plan on the observed asset beta and one method proposed to adjust for it. In Section 3 I summarise the broader literature and its implications for this procedure. In Section 4 I apply the analysis to seven regulated UK companies selected by Ofcom which have large DB pension plans and investigate whether there is a robust way of adjusting their asset betas for the presence of these pension plans. Finally, in Section 5 I give a summary and the conclusions of the report.

2. The Jin, Merton, and Bodie approach

A procedure for adjusting the observed asset beta for the presence of a DB pension fund has been suggested by Jin, Merton, and Bodie (2006) ("JMB"). It takes the standard asset beta of the firm and deducts from it an estimate of the risk emanating from the DB plan in order to give a "corrected" estimate of the pure operating asset beta. This is a useful starting point for the analysis in this report. In this Section I explain the JMB procedure and then, in later Sections, use it as the basis for a discussion of whether such an adjustment is possible for regulated UK firms.

The key to understanding the JMB procedure is to appreciate that the starting point for any cost of capital calculation is the observed systematic risk of traded equity.[1] In the standard asset beta calculation the beta of equity and the beta of debt are combined to give an estimate of the asset beta of the business:

$$\beta_{E+D} = \frac{E}{E+D}\beta_E + \frac{D}{E+D}\beta_D \qquad (1)$$

where β_{E+D} is the conventionally estimated asset beta, D is the market value of debt, E is the market value of equity, β_D is the debt beta, and β_E is the equity beta. The asset beta may then be used with the other parameters of the capital asset pricing model ("CAPM") to determine the cost of capital.

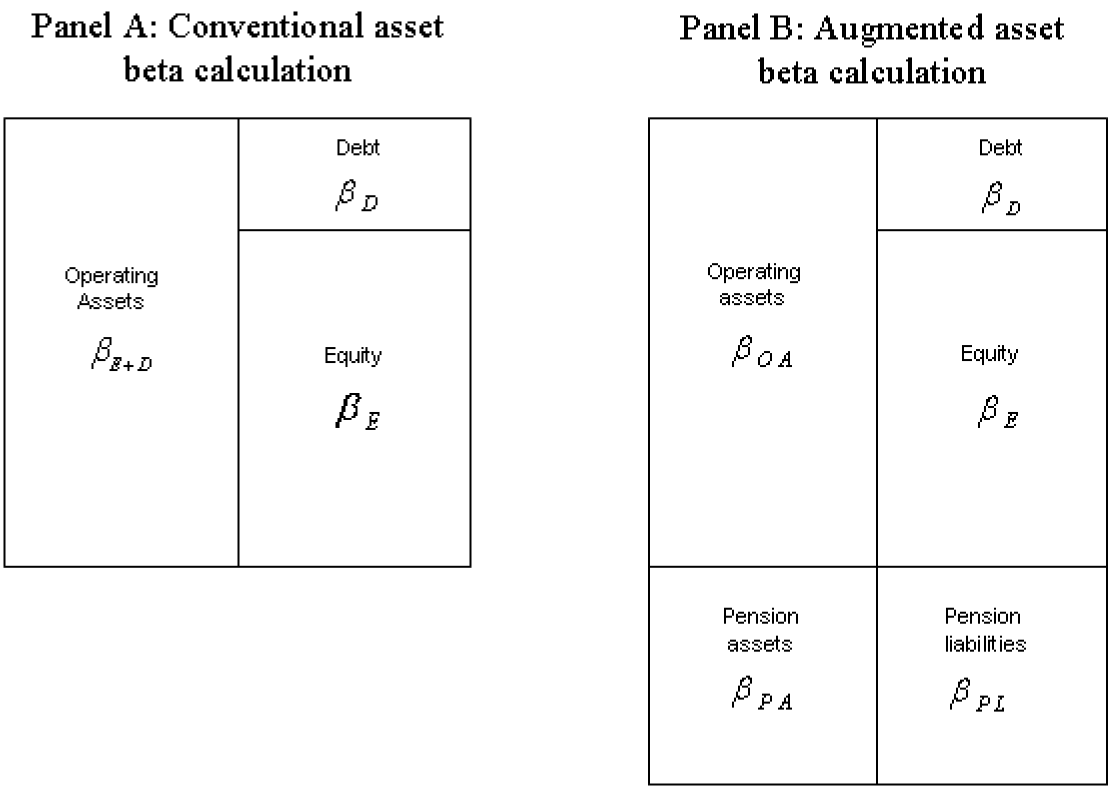
For a firm with no DB pension plan, the aggregate of equity and debt represent the total claims on the operating assets of the firm, as illustrated by Panel A of Figure 1. Therefore, the observed betas

[1] Throughout this document I discuss the effect of DB pension plans on the cost of capital using asset betas as the focus of the discussion. Similar analysis would apply if the cost of equity were estimated using other approaches, such as the dividend discount model. However, it is convenient to use the asset beta approach because estimation of the beta of the pension fund is more straightforward than applying these other approaches.

of the equity and debt claims may be combined in a weighted average based on their market values to give an estimate of the beta of the operating assets of the firm. As a result, the conventional asset beta defined by Equation (1) measures the risk of the operating assets.

For a firm with a DB pension plan the position is more complex, as illustrated by Panel B of Figure 1. In addition to its operating assets this firm has pension assets, and in addition to its standard financial liabilities (debt and equity) it has the liabilities of its pension fund. Therefore, the equity and debt betas potentially reflect not only the beta of the operating assets but also the betas of the assets and liabilities of the pension plan.

Figure 1: Illustration of the JMB approach to estimating the "correct" operating asset beta



The augmented market value balance sheet shown in Panel B of Figure 1 can form the basis of an adjusted calculation of the beta of the operating assets. Assuming that the weighted average of the betas of the assets and liabilities of the augmented balance sheet are equal gives:

$$OA\beta_{OA} + PA\beta_{PA} = D\beta_D + E\beta_E + PL\beta_{PL} \quad (2)$$

Where OA is the value of the operating assets, PA is the value of the pension assets, PL is the value of the pension liabilities, β_{OA} is the beta of the operating assets, β_{PA} is the beta of the pension assets, and β_{PL} is the beta of the pension liabilities.

Rearranging (2) gives the equation which JMB use to infer the "correct" beta of the pure operating assets:

$$\beta_{OA} = \frac{E}{OA}\beta_E + \frac{D}{OA}\beta_D - \left[\frac{PA}{OA}\beta_{PA} - \frac{PL}{OA}\beta_{PL}\right] \quad (3)$$

Where the value of the operating assets, OA, is calculated from the observed values of debt, equity, pension assets, and pension liabilities as:

$$OA = D + E + PL - PA \quad (4)$$

I discuss in more detail in Sections 3 and 4 below the assumptions implicit in equation (3) and their validity for UK regulated firms. However, before doing that it is useful to understand the intuition of the JMB adjustment and its potential size.

Using equation (3) rather than the standard equation (1) to estimate the beta of the operating assets involves an adjustment for the risk of the pension fund. JMB define a variable, $\beta_{PENSION}$, which measures the contribution of the risk of the pension fund to the risk of the firm:

$$\beta_{PENSION} = \beta_{PA}\frac{PA}{D+E} - \beta_{PL}\frac{PL}{D+E} \quad (5)$$

Their formula for the "corrected" beta of the pure operating assets is:

$$\beta_{OA} = \beta_{E+D}\frac{E+D}{OA} - \beta_{PENSION}\frac{E+D}{OA} \quad (6)$$

Equation (6) estimates the "pure" operating asset beta by taking the conventional asset beta, β_{E+D}, and removing from it the part of the observed risk emanating from the pension fund rather than the operating assets.

The nature of the adjustment can be seen by assuming that the pension fund is neither in deficit nor surplus, so that PL=PA and OA=D+E. For such a firm, Equations (5) and (6) simplify to:

$$\beta_{PENSION} = \frac{PA}{D+E}\left[\beta_{PA} - \beta_{PL}\right] \tag{7}$$

$$\beta_{OA} = \beta_{E+D} - \beta_{PENSION} \tag{8}$$

These equations show that the JMB adjustment primarily depends on:

- The difference between the betas of the assets and liabilities of the pension plan: $\left[\beta_{PA} - \beta_{PL}\right]$.
- The gross value of the pension plan relative to the value of the operating business of the firm: $\frac{PA}{D+E}$.

In simple terms, if the betas of the assets and liabilities of the pension fund are different, then the net value of the fund will be exposed to systematic (beta) risk. This beta risk will feed through to the observed equity beta of the firm. Equation (8) strips the net beta of the pension fund from the observed asset beta to give a "corrected" estimate of the asset beta of the pure operating business.

For firms with DB plans which are significant relative to the size of their operating business, the JMB adjustment can be large. JMB give the example of Boeing in 2002. They calculate a conventional asset beta of 0.543 and a "corrected" asset beta, which reflects only the risk of the operating business, equal to 0.228.[2] Hence, according to JMB, the adjustment required to take account of the risk of the Boeing pension fund was a reduction of the observed asset beta by 0.315. If the JMB analysis is correct, the "pure" operating asset betas of firms with large DB plans can be much lower than their conventional asset betas.

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[2] JMB Table 2.

The large adjustment calculated by JMB for the Boeing asset beta reflects two things. First, Boeing's pension fund had assets and liabilities of about $33 billion, whereas the value of its operating business was $42 billion. So the gross value of its pension fund was large relative to the value of its operating assets. Second, in their calculation for Boeing, JMB assume a beta of 0.59 for pension assets and 0.175 for pension liabilities. Using these inputs to Equation (7), the adjustment to the asset beta would be (33/42)*(0.59-0.175)=0.33. This is almost the same as the adjustment of 0.315 calculated by JMB using Equation (6). The minor difference is because the Boeing fund was in a small surplus. However, as this example illustrates, Equation (7) captures the important components of the JMB adjustment and the intuition of Equation (7) discussed above applies even when the fund is in surplus or deficit.

This example illustrates some important points about the JMB adjustment:

- What matters in the JMB adjustment is the gross size of the pension fund relative to the operating assets, not the size of the pension surplus or deficit.
- The other thing that matters is the difference between the betas of the assets and liabilities of the pension fund.
- The JMB adjustment can be very large.
- The JMB adjustment can result in inherently implausible estimates of the "correct" operating asset beta for a particular firm.

The last of these points is particularly important. It is highly unlikely that the true operating asset beta of Boeing in 2002 was as low as 0.228. Using JMB's assumption of an equity market risk premium of 7% this implies an asset risk premium of 1.6%, which is clearly too low given the nature of Boeing's business. The fundamental characteristics of commercial airplane manufacturing are not those of a low risk business, which the "corrected" operating asset beta implies. The commercial airplane manufacturing business has high economic revenue sensitivity and high fixed costs, both of which are associated with high asset betas.[3] Although Boeing also has a defense contracting business with a lower asset beta than its airplane manufacturing business, the defense business is not large enough to result in an overall operating asset beta as low as JMB suggest.

[3] See Brealey, Myers, and Allen (2008) pages 248-250.

In this instance the JMB procedure is resulting in an implausibly low estimate of the pure operating asset beta of Boeing. Hence, the JMB approach appears to be capable of giving inherently implausible results. Therefore, before adopting the type of adjustment proposed by JMB the following questions must be answered:

A. For firms with large DB pension plans, how strong is the <u>theoretical</u> basis for assuming that a large amount of the observed risk of their shares is generated by the risk of their pension funds?

B. How strong is the <u>empirical</u> evidence for assuming that the risk of DB pension plans feeds through to the observed betas of shares?

C. How easy is it to <u>measure</u> the inputs to the JMB method, and how robust is the method to measurement errors?

In the next Section I review the literature regarding these issues. In the following section I apply the JMB method to a sample of regulated UK companies and discuss measurement issues.

3. Literature review

Despite its simplicity, the JMB approach is based on some very strong assumptions. The nature of the assumptions can be seen by rearranging Equation (6) to give:

$$\beta_{E+D} = \beta_{OA}\left[\frac{OA}{E+D}\right] + \beta_{PENSION} \tag{9}$$

Thus the approach assumes that the conventionally observed asset beta, β_{E+D}, is generated by a combination of a "true" operating asset beta, β_{OA}, and the net beta of the pension plan, $\beta_{PENSION}$, defined by Equation (5). The important assumptions underlying this approach include:

A. Changes in the pension surplus or deficit "belong" entirely to the financial claimholders (equity and debt) of the firm, and not to pensioners or employees.[4]

B. There are no other stakeholders in the pension surplus or deficit.

[4] By this I mean that all increases in the surplus will ultimately be claimed by the shareholders or debtholders of the firm, and all deficits will ultimately be made good by these financial claimholders.

C. Pension risk does not change the beta of the operating assets of the firm.

D. The share price and equity beta of the firm immediately and fully reflect changes in the pension deficit or surplus.

Each of these assumptions has been examined in the literature and the conclusions regarding all of them are ambiguous. In combination, doubt about how to deal with them raises serious questions about the robustness of the JMB method as a practical approach to adjusting the cost of capital. In this Section I review the theoretical and empirical literature related to these questions.

3.1 The assumption that all changes in the value of the pension fund belong to shareholders

First, it is not clear that all changes in the surplus or deficit of a DB pension plan "belong" to the financial claimholders (debt and equity) of the firm. Beginning with Sharpe (1976) and Bulow and Scholes (1983) there is a long-standing debate about who owns the assets in a DB pension plan. Bodie and Shoven summarize the issues:

> "*[Bulow and Scholes] question the idea that the assets held in trust by defined-benefit pension plans of large corporations are corporate assets and that the obligation to pay employees during retirement is a corporate liability similar to secured debt. They feel that this view, which implies that any difference between the value of pension assets and the value of the liability is a part of shareholders' equity, is overly simplistic. Instead, they believe that the employees and stockholders share ownership of the pension fund.*" (Bodie and Shoven (1983))

If employees and financial claimholders share ownership of the pension fund, then only a proportion of the changes in the plans surplus or deficit will belong to the financial claimholders. In that case, the JMB adjustment will be too large.

Starting with Sharpe (1976) there have been attempts to model the sharing of risks between financial claimholders and the beneficiaries of DB plans using contingent claims analysis. A recent UK example is Hao (2008). The original insight of Sharpe was that DB plans involve the exchange of financial options between employees and the firm. However, using this approach to obtain a realistic valuation of pension liabilities is very complex. For the purposes of cost of capital estimation the only robust insight is that the pensioners of the fund share in its risks.

In terms of the JMB approach, the impact of this argument is that the beta of the pension liabilities will be increased by the participation of the beneficiaries in the success of the plan assets. The higher level of β_{PL} will reduce the size of $\beta_{PENSION}$ in Equation (5), and consequently result in a smaller adjustment to the asset beta. Consequently it will give a higher estimate of the corrected operating asset beta. This raises the important issue of how to measure the beta of pension liabilities, β_{PL} . As I have discussed above, the difference between β_{PL} and β_{PA} is what determines the size of the JMB adjustment. Any doubt about how to measure β_{PL} means that there must be doubt about the correct size of that adjustment. I discuss the measurement of β_{PL} in more detail in Section 4.4 below.

3.2 Other stakeholders in the pension surplus or deficit

Second, there are other stakeholders who participate in the surplus or deficit. Tax rules generally allow deductions for contributions to pension funds, whether they are made by the firm or by employees. Therefore, pension fund deficits may "belong" partly to the tax authorities. The mechanism is that deficits will result in increased contributions, increased future tax deductions, and reduced future taxes. The present value of these reduced taxes should be subtracted from the deficit when calculating how much of it "belongs" to the firm. Similarly, surpluses will result in increased taxes via reduced contributions. As a result, Black (1980) argued that a proportion of the risk of a pension fund is borne by the tax authorities and not by either the firm or its employees. His analysis implies that a proportion of risk equal to the effective company tax rate, T, is borne by the tax authorities. As a result, only (1-T) is borne by the firm or the employees. Other authors, such as Bulow et al (1987), have argued that the details of tax laws may reduce the amount of risk borne by the tax authorities so that the proportion of pension risk borne by the firm is between (1-T) and 1.

The JMB analysis assumes that no risk is borne by the tax authorities. Therefore, from a tax point of view Equation (5) above represents the upper limit of the size of $\beta_{PENSION}$. A simple way to adjust the JMB approach for risk-sharing by the tax authorities would be to multiply the value of $\beta_{PENSION}$

in Equation (5) by (1-T) to allow for the part of the risk borne by the tax authorities rather than the shareholders of the firm.

Another stakeholder which could affect the amount of the risk emanating from a pension fund borne by the firm's shareholders is pension insurance. Pension insurance schemes can have a direct effect on risk, via the guarantees they offer. However, for the UK Pension Protection Fund, this mainly affects the risk borne by pensioners rather than the risk borne by shareholders (McCarthy and Neuberger (2005)). From the perspective of cost of capital measurement, a more important impact of pension insurance is likely to be the effect of such insurance schemes on the behaviour of employees and the firm. The existence of pension insurance will affect wage bargaining, job decisions by employees, pension plan investment policy, and potentially many other decisions by the firm and its employees (Bulow, Scholes and Menell (1983), Zeckhauser (1983)). This is one aspect of a much broader issue: the existence of a DB pension scheme potentially changes the behaviour of the firm and its employees, which I discuss in the next subsection.

3.3 Is the "pure" operating asset beta independent of the existence of the pension plan and its surplus or deficit?

As I discussed in the introduction to this Section, the JMB approach implicitly assumes that there is a well-defined "pure" operating asset beta which is independent of the existence of the pension plan and of the level of its surplus or deficit. However, as I have just discussed, the existence of a DB pension plan, its structure, and other features such as pension insurance are all part of a general bargain between employees and the firm. Modelling this behaviour would involve the solution to a complex bargaining game. Although qualitative features of the solution to the game can be derived, obtaining quantitative estimates of the impact on shareholder risk is very difficult.

In terms of the JMB analysis, the implication of this line of analysis is that the adjustment to the asset beta is likely to be smaller than a naïve application of the JMB method suggests. If decisions taken by the firm and its employees reflect the existence of the DB pension plan, then the assumption that the operating asset beta is independent of the pension plan will not be true. The beta of the operating business will be changed by the existence of the plan. So the conventional asset beta cannot be expressed as the sum of a well-defined "pure" operating asset beta and the beta of the pension plan, as Equation (9) requires. In fact, similar to the discussion of risk-sharing between employees and the firm in Section 3.1 above, the impact of the plan on decisions by employees and the firm is likely to lead to sharing of the pension fund risk between the firm and its employees: "… *any bargaining theory, at this level of generality, will lead to some form of "split the surplus*"…" (Green (1983)).

Incorporating this into the JMB framework is difficult. Even the qualitative implications are not clear. If employees share in the pension fund deficit or surplus via the decisions they make about wages and other aspects of their employment, then the impact of the pension plan on equity risk could be attenuated by these decisions. In that case, the operating asset beta in the presence of the pension fund will be lower than the operating asset beta without it. From the shareholders' point of view, the amount of risk in the presence of a DB pension plan will be less than the sum of the "pure" operating asset beta and the pension fund risk. If the opposite is true, and decisions by employees amplify the effect of pension fund risk, then the effect on the observed asset beta will be greater than JMB suggest. Either way, it will be incorrect to calculate the "pure" operating asset beta in the way JMB suggest.

Whatever the interaction between the pension fund and operating decisions, there is a danger that the JMB calculation will give an estimate which has no real meaning since it is an estimate of the operating asset beta *in the presence of the DB pension plan* but is treated as if it is the operating asset beta *for a firm with no DB pension plan*. I discuss in Section 5 below whether it is possible to estimate the operating asset beta for a firm with no pension plan and also how such a number might be used in regulation.

3.4 The impact of regulation

Another issue which arises for regulated firms is whether the existence of a DB pension plan and its state of surplus or deficit affects the behaviour of regulators. At one extreme would be a case where the regulator regulates all the prices and profits of a particular firm and allows the regulated firm to recapture all of any pension fund deficit through its product pricing policy. For instance, the regulator might directly allow cash flows paid by the firm into the pension plan to be included as part of the regulatory cost base. In that case almost all the risk emanating from the pension plan would be borne by the customers of the firm and not by its shareholders or employees. Then the conventionally measured asset beta would not reflect any risk arising from the pension plan. There would be no need for the JMB adjustment because the conventional asset beta would reflect only the risk of the operating assets and not any extra risk for shareholders emanating from the pension plan. A similar effect would occur even if the pass-through mechanism were not so direct, but occurred because the state of the pension deficit or surplus was expected to affect the future behaviour of the regulator. At the other extreme would be the case where the regulator insists that risks emanating from the pension plan should not be passed on to customers. In that case the situation would be similar to the case of non-regulated firms discussed above.

It is difficult to know how much of the pension surpluses or deficits of UK regulated firms will ultimately be passed to consumers. It depends on the proportion of the value of the regulated firm that is either directly or indirectly affected by regulation, pension accounting, the regulator's statutory duty, the exercise of regulator discretion, and other factors. There is no obviously correct assumption regarding these matters.[5] The issue is also complicated by the fact that what matters is the assumption which is embedded in share prices. This is determined by stock market investors, and their expectations may be different to the regulator's actual intention. It is the market's assumption that matters because that is what will be captured in the observed asset beta. This raises the important question of how capital markets actually respond to pension fund deficits and surpluses, which I discuss in the next subsection.

3.5 Does the beta of the pension plan feed through to the conventionally measured asset beta?

A final important assumption of the JMB approach is that share prices fully and immediately reflect the surplus or deficit in a DB pension plan. Equation (9) assumes that the observed conventional asset beta reflects the entire net beta of the pension plan. The only way to assess whether this is true is by empirical analysis of share prices. There are two types of such tests in the literature, both using US data.

One test is to run cross-sectional regressions of firm values on a battery of independent variables including pension surpluses or deficits. A good example of this type of approach is Bulow, Morck, and Summers (1987). The results of this literature are summarized by Scholes (1987):

[5] See, for instance, "Don't leap to assumptions", *Financial Times*, 15 July 2009, page 18.

> *"Although we might disagree with their methodologies, these papers, on average, show that unfunded liabilities are reflected in stock prices. Most of the papers ….. produce coefficients with such large standard errors that it is impossible to judge how accurately the unfunded liabilities of pension funds are reflected in security prices."*

The large standard errors in these cross-sectional tests arise from a number of profound econometric difficulties. According to Scholes, it is "impossible to judge" from such tests how pension surpluses or deficits are reflected in share prices. It is, therefore, also impossible to judge whether the assumption underlying the JMB adjustment is true.

In financial econometrics, the standard solution to such econometric difficulties when analyzing share prices is to examine time-series data. Bulow, Morck, and Summers (1987) conduct a time-series test from which they conclude that the amount of the measured pension fund deficit which is reflected in share prices "*is only about half the value that would be predicted by a naïve model in which firms "owned" all unfunded liabilities and none of the other complicating factors* [pension insurance, labour bargaining, tax, employee sharing in the pension deficit] *arose*." This result implies that the size of the adjustment calculated by a naïve application of the JMB method will be twice what it should be.

An even stronger result is found by Franzoni and Marin (2006). They investigate the timeliness with which the market impounds into share prices the effect of pension deficits and conclude:

> "*Investors do not anticipate the impact of the pension liability on future earnings, and they are surprised when the negative implications of the underfunding ultimately materialize.*"

Thus, according to Franzoni and Marin, although the market ultimately does include the effect of pension deficits in share prices it does not do it in the timely way which is necessary for the JMB adjustment to work. Their adjustment relies on the assumption that measured betas of pension fund assets and liabilities feeding directly through to the measured share price beta, as Equation (9) assumes. If there is a lag in this process, then Equation (9) will overstate the impact of the net pension fund beta on the measured asset beta. As a result, subtracting the pension fund beta from the measured asset beta will give too low an estimate of the "pure" operating asset beta.

There is another issue when decomposing observed betas in the way JMB advocate. Their method embodied in Equation (9) assumes that betas are generated only by fundamentals. In fact, there is a growing literature which suggests that part of beta is generated by trading effects (see for instance, Campbell and Vuoteenaho (2004)). The quantitative implications of this literature for methods which decompose observed betas, such as JMB, are far from clear. However, the qualitative implications are similar to those of the Franzoni and Marin result. If the linkage between observed betas and fundamentals is weakened by pure trading effects on share prices, then relationships such as Equation (9) which rely on betas reflecting only fundamentals will be weakened.

In summary, although there is evidence that pension deficits and surpluses ultimately affect the level of share prices, there is no convincing evidence that short-term fluctuations in the net value of pension funds are immediately and totally reflected in the short-term fluctuations in share prices which are measured by beta. The JMB adjustment requires that there is such a direct link, but the evidence from the literature does not support such a strong conclusion. Therefore, any empirical support for making the JMB adjustment must rest on the empirical evidence in the JMB paper itself, which I discuss in the next Section.

3.6 The empirical evidence in JMB

Almost all of the effects discussed so far in this Section have the result of attenuating the amount of pension risk which passes from the pension fund to the observed share price. In contrast, the JMB analysis is based on the assumption that measured pension risk appears immediately and totally in the observed equity beta, as Equation (9) assumes. The question of which assumption is correct can be answered only empirically. Therefore, JMB's empirical tests are an important indicator of the robustness of their method for potential application in UK regulation.

As Equation (7) shows, a key input to the JMB adjustment is the difference between β_{PL} and β_{PA}. A key assumption, shown by Equation (9), is that the entire risk of the pension fund flows through to the conventional asset beta. JMB test the validity of these assumptions by running the regression:

$$\beta_{E+D} = a + b\beta_{PENSION} + cCONTROLS + \varepsilon \qquad (10)$$

where CONTROLS are variables that include various proxies for the true operating asset beta.[6] Their hypothesis is that the coefficient b should be equal to 1.0, indicating that all the pension risk flows through to the conventional asset beta. In order to implement (10) they require an assumption about β_{PL}, which they cannot measure directly. So another part of their hypothesis is that the value of β_{PL} which gives the best fit of (10) should be realistic.

To implement (10) JMB measure an average β_{PA} of 0.67 and report results for two different levels of β_{PL}, 0.175 and 0.46. I discuss in Section 4.4 below why they think that β_{PL} might be as high as 0.46. Table 1 below shows the results of the regression for JMB's base case assumptions. For both levels of β_{PL} the coefficient b is statistically indistinguishable from 1.0, consistent with the JMB hypothesis. However, the fit of the regression is *almost independent of the level of* β_{PL}. Hence, their empirical results do not provide an answer to a central issue involved in implementing their method: What is the correct assumption about β_{PL}? In fact, using R^2 as a criterion, the better value of β_{PL} in Table 1 is 0.46. If that level of β_{PL} is adopted the regression coefficient b is less than one, consistent with the hypothesis that only part of the pension risk passes through to the observed equity price.

Table 1: Results of the JMB test: Value of the coefficient b and level of R^2

	$\beta_{PL} = 0.175$	$\beta_{PL} = 0.46$
Coefficient b (Standard Error)	1.22 (0.22)	0.85 (0.13)
R^2	37.62%	37.85%

Therefore, the JMB empirical evidence is consistent with two totally different interpretations of the effect of DB pension risk on observed asset betas. On the one hand, the first column of Table 1 is consistent with $\beta_{PL} = 0.175$ and b=1, which would mean that a large part of the observed asset beta of companies like Boeing is generated by pension risk and the "true" operating asset beta is low. On the other hand, the second column of Table 2 is consistent with $\beta_{PL} = 0.46$ and b=0.85, implying

[6] There are significant econometric issues involved in this regression and it is quite possible that there are omitted variables which are correlated with both β_{E+D} and $\beta_{Pension}$. JMB take care to include as controls most variables whose omission would bias the regression, but it is still possible that their controls are not complete. If there are such omitted variables, the bias could be in favour of accepting their hypothesis, even if it is not true.

that the part of the observed asset beta being generated by pension risk is much smaller and the "pure" operating asset beta is close to the observed operating asset beta. Using the Boeing example discussed in Section 2, the adjustment to the asset beta is 0.315 with $\beta_{PL} = 0.175$ and b=1 but if $\beta_{PL} = 0.46$ and b=0.85 it is only 0.066.

3.7 Literature review: Summary of implications for implementing the JMB adjustment

In summary, the literature implies two things:

- Measured share prices do reflect, to some degree, measured pension deficits and surpluses. So the measured asset beta of a firm with a DB pension plan will reflect, to some degree, the measured risk of its DB pension fund.
- The amount of pension risk included in the asset beta of a typical firm appears, on the basis of both theoretical and empirical results, to be smaller than a naïve application of the JMB method assumes.

Almost all of the effects discussed in this Section attenuate the amount of pension risk passed through from the pension fund to the observed share price:

- sharing of pension risks between pensioners and the firm,
- sharing of pension risks with the government through taxes,
- sharing of pension risks with pension insurance schemes,
- sharing of pension risk with employees through the labour bargaining process,
- slippage between the measured pension risk and its impact on the share price.

A naïve use of the JMB method will fail to take account of these effects and will give an adjustment for the beta of the pension fund which is too large. As a result it will give an estimate of the "pure" operating asset beta which is too low. In my opinion, this is almost certainly the reason that the JMB analysis of Boeing discussed in Section 2 above gives an unreasonably low estimate of the "pure" operating asset beta.

For regulated firms there is an additional complication. If the stock market expects some of the pension fund risk to be passed to customers via the regulatory process, that will also reduce the amount of pension risk which shows up in the measured asset beta. In the extreme case where the market expects that regulation will allow all pension fund risk to be passed to customers, then no adjustment of the JMB type should be made and it would be an error to include such an adjustment in the cost of capital calculation.

Unfortunately, the literature does not provide definitive answers to three key questions involved in applying the JMB method to adjust the asset betas of UK regulated firms:

- What assumption about β_{PL} should be used?
- How much of the pension fund risk should be assumed to pass through to the measured asset beta?
- How does regulation affect the amount of pension fund risk reflected in the measured asset beta of a UK regulated firm with a DB fund?

In the next Section I attempt to apply the JMB method to adjust the asset betas of some regulated UK firms and discuss these implementation issues in more detail.

4. Analysis of a sample of UK regulated companies

To investigate the practicality of applying something like the JMB adjustment to UK regulated firms, Ofcom have asked me to attempt to apply it to BT, National Express, National Grid, Scottish and Southern, Severn Trent, Stagecoach, United Utilities. These are all large regulated companies with traded shares and DB pension fund. Therefore they provide a varied sample on which to test the practicality of the method. In this section I give the results of the analysis and discuss various issues which arise in implementing the method.

4.1 Naïve application of the JMB method

As the starting point of the analysis I first apply the naïve version of the JMB method in the way they advocate. The base case assumptions are given below. The latest annual reports used are the latest available as of the writing of this report in July 2009.

- E: Market Capitalization at 30 June 2009 from DataStream.
- D: Where available, market value of Net Debt, otherwise book value of Net Debt.
- Leverage: Average of last two years.
- β_E : Calculated using 2 years of daily data vs the FTSE All Share Index ending on 30 June 2009.
- β_D : 0.175 if the credit rating is A or above, 0.25 if the rating is BBB.
- β_{PA} : Calculated based on the breakdown of pension assets disclosed in the latest annual report, assuming betas of 1.0 for equity, 0.175 for debt, 0.006 for alternate assets, and 0.15 for property.
- β_{PL} : 0.175
- PA: Pension asset value from the latest annual report.
- PL: Pension liability (obligation) value from the latest annual report.

Table 2 shows the inputs to the JMB calculation. Table 3 shows the result of applying the naïve JMB adjustment using these assumptions.

This calculation is not intended to represent my best guess of the asset betas of these companies or of the correct adjustment for the pension fund. It is simply a starting point for the discussion which follows in this Section, where I discuss whether there is a robust procedure that can be used to make an adjustment for the pension fund. This starting point is chosen to reflect the assumptions JMB advocate and Ofcom's preferred method of estimating equity betas, two years of daily data.

Table 2: Inputs to base case calculation of the naïve JMB adjustment

	E	D	Beta E	Beta D	PA	PL	OA	Beta PA	Beta PL
BT GROUP	11,140.42	7,081.83	0.88	0.25	29,353.01	33,326.00	22,195.24	0.41	0.175
NATIONAL EXPRESS	933.65	718.14	0.87	0.25	849.60	957.10	1,759.29	0.70	0.175
NATIONAL GRID	17,628.39	18,374.54	0.70	0.18	14,797.00	16,000.00	37,205.93	0.52	0.175
SCOT.& SOUTHERN ENERGY	11,748.69	3,557.13	0.66	0.18	1,786.80	1,929.80	15,448.82	0.45	0.175
SEVERN TRENT	2,944.99	3,438.97	0.66	0.18	1,075.00	1,308.00	6,616.96	0.59	0.175
STAGECOACH GROUP	1,121.68	376.26	0.86	0.25	1,474.60	1,432.10	1,455.44	0.72	0.175
UNITED UTILITIES GROUP	4,837.05	3,687.66	0.67	0.25	1,483.80	1,696.90	8,737.81	0.63	0.175

The results in Table 3 show that the naïve JMB adjustment using $\beta_{PL} = 0.175$ can be large for these companies. In particular, the adjustment for BT is very large because the gross value of its pension fund is very high relative to its operating assets. According to this calculation, its pension assets have a relatively low beta (0.41). Hence the difference between the beta of the assets of its pension fund and the beta of the pension fund liabilities is smaller than for the other firms. However, BT has a pension fund which has a very large gross value relative to its operating assets. Even with a relatively small difference in the betas of the assets and liabilities of the pension fund, the large gross value of the pension fund results in a large adjustment from the observed conventional asset beta to the adjusted "pure" operating asset beta. The Stagecoach Group also has a large adjustment, for a slightly different reason. Its pension fund is not as large as the BT fund, relative to its operating assets. However, the estimated beta of its pension assets is higher, at 0.72, resulting in an adjustment to its beta even larger than that for BT.

Table 3: Result of the naïve JMB adjustment applied to base case assumptions

	Net Pension beta	Conventional Asset beta	Adjusted Asset beta	Adjustment
BT GROUP	0.34	0.64	0.24	-0.39
NATIONAL EXPRESS	0.26	0.60	0.32	-0.28
NATIONAL GRID	0.13	0.43	0.29	-0.14
SCOT.& SOUTHERN ENERGY	0.03	0.55	0.51	-0.04
SEVERN TRENT	0.06	0.40	0.32	-0.08
STAGECOACH GROUP	0.54	0.71	0.17	-0.53
UNITED UTILITIES GROUP	0.07	0.49	0.40	-0.08

For BT and Stagecoach the result of the large adjustment is an implausibly low estimate of the "pure" operating asset beta. For instance, the adjusted asset beta of 0.24 for BT is not a credible estimate of the true beta of its operating assets. For the reasons discussed in the previous Section, the naïve version of the JMB method combined with a low estimate of the beta of the pension liabilities gives too large an adjustment and, consequently, too low an estimate of the "pure" operating asset beta. For the other companies in Table 3 the size of the adjustment is smaller, but still material.

Because it gives inherently implausible results for some companies and also because the literature discussed in the previous Section suggests that it involves unrealistic assumptions, I do not advocate the naïve version of the JMB method. Therefore, I now examine the impact of the various assumptions which go into the JMB formula and consider whether there is an adapted version of the method that can be used as a robust way of adjusting the observed asset betas of these companies for the risks of their pension plans.

4.2 Sensitivity analysis

In this Section I vary the inputs to the JMB formula to see which assumptions are critical. Table 4 shows the effect on the size of the adjustment of changing certain assumptions. Using BT as an example, the first row of Table 4 shows a value of -0.39, the adjustment required to go from the observed conventional asset beta (0.64) to the pure" operating asset beta (0.24) given in the final column of Table 3. Each other row of Table 4 shows the size of this adjustment when one of the base case assumptions is changed.

The first panel of Table 4 shows the effect of using different methods of estimating the conventional asset beta: using 5 years of monthly data to estimate the equity beta, using 1 year of daily data to estimate the equity beta, using 2 years of weekly data to estimate the equity beta, using β_D = 0.2 if the credit rating is A or above and 0.3 if the rating is BBB, and using the latest leverage ratio rather than the average over two years. For instance, if 5 years of monthly data are used to estimate the equity beta of BT, rather than 2 years of daily data, the adjustment changes from -0.39 to -0.42, which is well within any margin of error. None of the changes in the first panel make a material difference to the size of the JMB adjustment. Therefore, it is possible (fortunately) to separate discussion of the size of the adjustment for the pension fund from discussion of the correct way to estimate the conventional asset beta. Hence in what follows I make no comments on the normal issues which are debated in cost of capital estimation and focus only on the size of the adjustment required for the presence of the DB pension fund.

Table 4: Sensitivity analysis of the JMB adjustment required to convert the observed conventional asset beta into a "pure" operating asset beta

Adjustment	BT GROUP	NATIONAL EXPRESS	NATIONAL GRID	SCOT.& STHERN ENERGY	SEVERN TRENT	STAGE COACH GROUP	UNITED UTILITIES GROUP
Base Case	-0.39	-0.28	-0.14	-0.04	-0.08	-0.53	-0.08
Changing inputs to Conventional Asset Beta							
Equity Beta 5Y Monthly	-0.42	-0.32	-0.14	-0.04	-0.07	-0.53	-0.08
Equity Beta 1Y Daily	-0.39	-0.28	-0.15	-0.04	-0.07	-0.54	-0.08
Equity Beta 2Y Weekly	-0.38	-0.29	-0.15	-0.04	-0.08	-0.53	-0.09
Higher Debt Beta	-0.40	-0.28	-0.14	-0.04	-0.08	-0.53	-0.09
Latest Leverage	-0.37	-0.27	-0.14	-0.04	-0.07	-0.54	-0.08
Measurement of PA and PL							
3 Yr Avg PA & PL	-0.45	-0.33	-0.15	-0.04	-0.08	-0.49	-0.11
Measurement of Beta PA & Beta PL							
Using Beta of MSCI World Index to FTSE ALL share (2 Yr Daily)	-0.27	-0.19	-0.10	-0.02	-0.05	-0.34	-0.06
Using Beta of MSCI World Index to FTSE ALL share (5 Yr Monthly)	-0.37	-0.27	-0.14	-0.03	-0.07	-0.50	-0.08
Using Beta of Alternate Assets of 1	-0.66	-0.28	-0.17	-0.06	-0.08	-0.60	-0.09
Using Beta PL = 0.46	0.03	-0.12	-0.02	0.00	-0.02	-0.25	-0.03
Using Beta of MSCI World Index to FTSE ALL share (2 Yr Daily) & Beta PL = 0.46	0.16	-0.04	0.03	0.01	0.01	-0.06	0.00

The second sensitivity analysis panel in Table 4 shows the effect of using a 3-year average of the pension values, PA and PL, rather than using the latest values. This also makes little difference to the size of the adjustment and I do not discuss measurement of PA and PL further. Even though much debate in the analysis of pensions focuses on the measurement of the value of pension liabilities (PL) this issue is not central to the measurement of the effect being discussed here. What matters is accurate measurement of the beta of pension liabilities (β_{PL}) not accurate measurement of their value.

The final panel of Table 4 shows the effect of varying the assumptions about β_{PA} and β_{PL}. As discussed above, these are crucial inputs to the JMB method, which the sensitivity analysis confirms. First, I vary the beta of the pension assets by changing the assumption that the equities held in the pension fund have a beta of 1.0 with respect to the FTSE All Share Index. To allow for the effect of international diversification I use instead the beta of the MSCI World Index, measured in sterling, relative to the FTSE All Share Index. Using 2 years of daily data this is 0.71, and with 5 years of monthly data it is 0.95. This lowers β_{PA} and, consequently, reduces the size of the JMB adjustment. In reality, UK pension funds hold equities which have a "home bias" but are somewhat internationally diversified. Therefore, the correct adjustment is likely to be between the two figures given by the assumed equity beta of 1.0 and an assumed equity beta equal to the beta of the MSCI world index.

The other sensitivity with respect to β_{PA} in Table 4 is to assume that the category "alternate assets" disclosed in the breakdown of pension assets are not cash, as the base case assumes, but other assets with a beta of 1.0. This might be consistent with them consisting of certain types of hedge funds or private equity investments. This assumption raises the absolute size of the adjustment.

Changing these assumptions about β_{PA} all have an effect on the size of the adjustment, but it always remains negative. Therefore, accurate measurement of β_{PA} is important in determining the exact size of the adjustment, but it is not critical in describing its qualitative features. For any realistic level of β_{PA} the "pure" operating asset beta is below the measured asset beta. I discuss the measurement of β_{PA} further in the next subsection.

The next row of the Table investigates the sensitivity to β_{PL}. Changing β_{PL} to 0.46, the alternative assumption employed by JMB, has a major effect on the size of the adjustment. It reduces the adjustment to close to zero for most firms. Thus the most crucial assumption is the level of β_{PL}. However, as I have said in Section 3.6 the level of β_{PL} cannot be clearly determined from the JMB analysis. I discuss the estimation of β_{PL} in more detail in Section 4.4 below.

The final row of the table shows the assumption $\beta_{PL} = 0.46$ combined with a globally diversified portfolio of equities. In this case, the adjustment is even reversed in some cases. These assumptions can give β_{PL} greater than β_{PA}.

In summary, sensitivity analysis of the JMB adjustment applied to this sample of UK regulated firms demonstrates:

- The size of the adjustment can be discussed independently of the standard arguments about the correct way to estimate the conventional asset beta.
- If the JMB method is used, the key questions are how to estimate β_{PA} and β_{PL}.

I now discuss each of these in more detail. However, I note that the general question of whether to use the JMB adjustment at all for regulated firms remains. I discuss this further in Section 5.

4.3 Measurement of β_{PA}

Measurement of β_{PA} using public data is made difficult by not knowing what assets are included in the category "alternate assets" of the pension fund disclosed in published accounts and also how globally diversified is the equity portfolio of the pension fund. It is artificial to devote time to these issues, since they can be resolved as matters of fact by obtaining the actual data from companies if a regulator wishes to use something like the JMB method. However, the broad level of β_{PA} affects the discussion of β_{PL} below, so I conducted a test to check whether the estimates of β_{PA} I am using are broadly correct.

I obtained from the companies' balance sheets the value of their pension assets on each of the last six year balance sheet dates. I matched these to levels of the FTSE All Share index and calculated a beta for each firm using the five years of returns data.[7] Although it is very crude to use only five years of annual returns to measure a beta, the highly diversified nature of the pension fund assets means that this procedure will give a broad indication of β_{PA}. Table 5 shows the result. The first column is the estimates of β_{PA} resulting from this direct estimation method. The second column is the estimate from Table 2, which is based on assumed betas applied to the subclasses of pension assets.

Table 5: Rough check on the level of β_{PA}

	Direct estimate	Implied from pension breakdown
BT GROUP	0.58	0.41
NATIONAL EXPRESS	0.55	0.70
NATIONAL GRID	0.19	0.52
SCOT.& SOUTHERN ENERGY	0.48	0.45
SEVERN TRENT	0.63	0.59
STAGECOACH GROUP	0.17	0.72
UNITED UTILITIES GROUP	0.72	0.63
AVERAGE	**0.47**	**0.57**

The average level of β_{PA} using direct estimation from the disclosed pension fund asset values is 0.47. The level implied by applying betas to the different asset categories within the fund is 0.57. A

[7] The return for the pension fund assets is not measured accurately by this procedure, because it omits cash flows into or out of the fund. However, if these are roughly constant over the period, then the beta estimate for the fund will be approximately unbiased.

likely source of the difference is that the pension breakdown method assumes a beta of 1.0 for the equity portfolio, as discussed above. Since all the equity portfolios of UK pension funds will have some degree of international diversification, it is likely that their actual betas relative to the FTSE All Share Index are lower than 1.0. This will mean that the level of β_{PA} is somewhat lower than that given by the pension breakdown method, as Table 5 broadly confirms.

In what follows, I assume that the beta of the pension assets is broadly around 0.5, but note that the actual value could be resolved as a matter of fact by having access to the details of pension fund assets in any particular instance.

4.4 Measurement of β_{PL}

Unlike measurement of the beta of the pension assets, the measurement of β_{PL} is not capable of simple resolution by having access to the details of the pension fund. There are three reasons for this:

- First, the actual beta of the claims held by pensioners is untraded. Therefore its beta cannot be measured directly and must be inferred by analogy with the betas of traded securities.
- Second, as discussed above, the way the pensioners of a DB fund share in the risk of the fund's assets is unclear and very difficult to measure.
- Third, to give an accurate estimate of the "pure" operating asset beta, the value of β_{PL} used should also proxy for risk-sharing in the pension fund by other agents such as tax authorities, as discussed above.

Regarding the first of these issues, measuring the beta of the claim held by the fund's pensioners, actuarial values do not provide an adequate basis for the estimation since they are not clearly mark-to-market values in any meaningful sense. Also, I am not aware of any traded entities from which this beta can be inferred. Therefore, what is needed is a value of β_{PL} which reflects the characteristics of the pension claim by pensioners <u>and</u> the claims on the pension assets held by agents other than the shareholders and debtholders of the firm. This beta should reflect:

- The long-duration of the pension liabilities;

- Relationships between expected longevity, expected real wage growth, and the level of the stock market;
- Potential risk-sharing by pensioners in the risk of the pension assets;
- Any sharing in the risk of the pension assets by agents other than pensioners, shareholders, and debtholders.

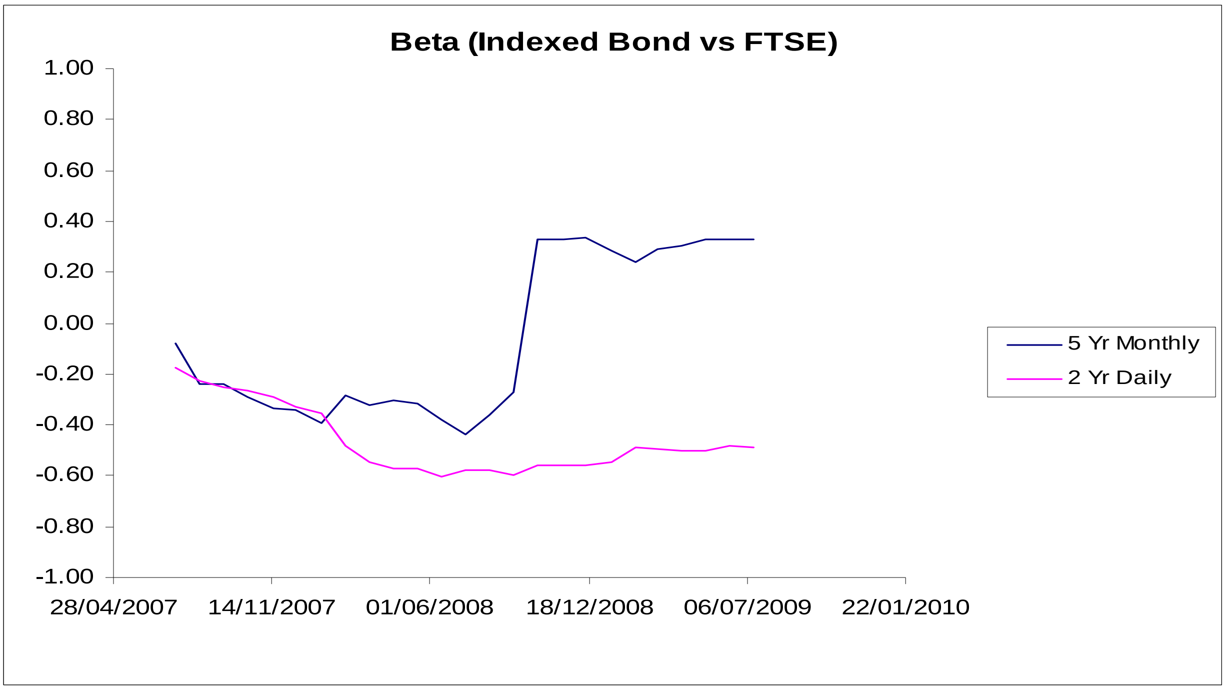
Much discussion of the risk of pension liabilities focuses on the third of these components. The JMB base case makes the relatively standard assumption that this can be captured by assuming that the pension liabilities have a level of risk equal to corporate debt. That is where the assumption that $\beta_{PL} = 0.175$ comes from.

Regarding the fact that pension liabilities have a very long duration, JMB note that such claims do not necessarily have a beta of zero, even if they are default-free. In fact, a surprisingly high level of beta for long-duration fixed income securities has been noted by Cornell (1999). The alternative higher estimate which JMB use, $\beta_{PL} = 0.46$, is based on a regression of returns from a 30-year Treasury Bond on the equity market using five-years of monthly data. In other words, for the period they look at, even if the pension liabilities had been considered to be default free and just like long-term Treasury Bonds, they would have had a beta of 0.46. This result fluctuates widely over time, as both Cornell and JMB note.

Although JMB use the beta of a long-duration nominal bond to proxy the beta of default-free DB pension liabilities, it is arguable that an index-linked bond is a better proxy. Therefore, I ran a 60-month regression of the returns to the UK Treasury 2% Index-linked Gilt of 2035 on the FTSE All Share Index. For the period up to 30 June 2009 the beta was 0.33. However, this result is highly sensitive to the period of data chosen, and also to the method of measurement. Figure 1 shows the betas of this index-linked bond using different data windows and also using 2-years of daily data rather than 5-years of monthly data. The 5-year monthly estimate fluctuates widely, and the 2-year daily estimate is completely different.

Thus even if the pension liabilities are considered to be default-free and even if there is no other risk-sharing in the risk of the pension fund, it is difficult to estimate the beta of the pension liabilities in a way which takes account of their very long duration. This difficulty is complicated further by the fact that the present value of DB pension liabilities will rise in value when expectations of longevity rise unexpectedly and when expectations of real wage growth rise unexpectedly. Both of these are likely to be correlated with the level of the stock market. There is, to my knowledge, no simple way of adjusting the beta of pension liabilities for this effect.

Figure 1: Beta of UK Treasury 2% Index-linked Gilt of 2035 on the FTSE All Share Index



Finally, even if it were possible to get a good estimate of the beta of the pension liabilities which allows for both credit risk and their long duration, it would also be necessary to include in β_{PL} the effect of risk-sharing by other agents in the risk of the pension fund assets. As discussed extensively above, this is almost impossible to quantify accurately. Combined with the other uncertainties about β_{PL}, this means that it is almost impossible to obtain an accurate determination of β_{PL} for the purpose of implementing the JMB method.

Given these difficulties, the only realistic approach would be to adopt an estimate of β_{PL} based on the type of empirical analysis given in the JMB paper. However, as discussed above, their empirical analysis produces such a wide range of possible values for β_{PL} that it does not help. Therefore, accurate measurement of β_{PL} <u>to reflect all the factors required to implement the JMB adjustment</u> is virtually impossible. Without a definitive empirical approach to infer the level of β_{PL} from the way that DB pension risk actually affects measured asset betas, there is no robust method of measuring β_{PL} for this purpose.

4.5 Other evidence

There is one implication of the JMB analysis which has not, to my knowledge, been investigated in the literature. If the existence of a DB pension fund influences the equity beta of a firm, it should also influence other statistical properties of the firm's share price. In particular, it should raise the R^2 between the company's return and the stock market return. The reason is as follows. Risk emanating from the pension plan is likely to have far a far smaller company-specific component than risk emanating from the operating business. The pension fund risk is generated by a diversified portfolio of securities, which has little specific risk. Therefore, risk emanating from the pension fund will have a high correlation with the market. As a result, a company with a large DB plan will have a lot of risk with a high correlation with the market and its share price behaviour should reflect that.

If the naïve version of the JMB adjustment is correct, the effect of a large DB plan on the R^2 of a firm's share price should be considerable. For instance, BT has a pension plan of about £30billion gross value and a firm value (debt plus equity) of about £18 billion. As Table 2 above has shown, the naïve version of the JMB adjustment implies that more than half of BT's share price risk is coming from its pension fund. If this were true, then given the highly diversified nature of pension fund risk the R^2 of BT's share price with the stock market should be very high. To investigate whether this is the case I obtained from the London Business School Risk Measurement Service, April-June 2009, estimates of the R^2's of the FTSE 100 and FTSE 30 companies. I compared these with the R^2 for BT. I use BT because, of the companies discussed above, it has the largest pension fund relative to the value of its operating assets. Table 6 shows the result of this exercise.

Table 6: Comparison of R^2's with the FTSE All Share Index

	FTSE 30 Index Stocks	FTSE 100 Index Stocks
Average R^2	27%	28%
Median R^2	28%	27%
BT R^2	33%	33%

Based on these data there is no reason to believe that the systematic risk from BT's very large pension fund is showing up in an abnormally high correlation with the stock market, as the naïve version of the JMB adjustment would imply. BT's correlation with the stock market is somewhat higher than average, but not nearly to the degree that would be implied if a large part of its risk were flowing directly through from its pension fund to its measured equity beta. Given that many of the other companies in the index are more international than BT one might expect its operations anyway to have a higher R^2 with the local market index than the average index constituent. So the evidence that a significant part of BT's observed risk is derived from its pension fund is very weak based on these data.

This result is broadly consistent with the conclusions expressed above: that other risk-sharing mechanisms attenuate the effect of the pension fund on the measured beta, that the market may expect regulation to also reduce the flow-through of pension risk to the share price beta, and that models which attribute all measured beta to the effect of fundamentals are incomplete.

4.6 Analysis of a sample of regulated UK companies: Conclusions

Naïve application of the JMB method to a sample of regulated UK companies gives some potentially large adjustments to get from the observed asset beta to the "pure" operating asset beta. However, as a result it gives some estimates of the "pure" operating asset beta which are inherently implausible. The reason is that the naïve version of the method does not allow for:

- The potentially high level of beta of pension liabilities because of their long duration;
- Sharing in pension fund risk by other agents;
- The effect of regulation attenuating the effect of pension fund risk on measured equity risk;
- Other slippage between pension fund risk and share price response.

In terms of the JMB approach, the first two of these could be captured by using an appropriate value for β_{PL}, but there is no robust viable approach available to obtain such an estimate. The size of the adjustment is very sensitive to β_{PL}. Furthermore, even if such an estimate could be obtained it would still leave the open questions of how much pension risk the market expects the regulator to pass to customers and the extent to which other slippages undermine the link between the beta of the pension fund and the observed asset beta.

Therefore, in my opinion the JMB method cannot be used as a reliable way to adjust observed asset betas in order to obtain "pure" operating asset betas for use in UK regulation. However, there are two positive conclusions of the analysis:

- The size of the adjustment to the asset beta to allow for the risk emanating from the pension fund is largely independent of the method used to estimate the asset beta. Therefore, the size of the adjustment can be debated independently of the standard arguments about how to estimate the asset beta.
- No reasonable set of assumptions gives a result where the "pure" operating asset beta is above the observed conventional asset beta. Therefore, the conventional asset beta may be used as an upper limit of the "pure" operating asset beta.

5. Summary and conclusions: Is there a robust way of adjusting the measured cost of capital of UK regulated firms for the risk emanating from their DB pension plans?

In this section I briefly summarise the analysis and conclusions of the report. The issues are:

- Is it possible to take a conventional asset beta and adjust it for the presence of a DB pension fund to give a robust estimate of the "pure" operating asset beta of a firm?
- If it is not possible to do this, how could one measure such a "pure" operating asset beta?

Regarding the first of these issues I conclude that there is no robust method available. I discuss the second issue below.

An authoritative paper by Jin, Merton, and Bodie (2006) has suggested a method of adjusting the observed asset beta to give a "pure" operating asset beta. However, used in a naïve way their method can result in very large adjustments and implausibly low estimates of the beta which should be applied to the operating assets.

The JMB method assumes that all risk emanating from the pension fund flows directly and immediately through to the shareholders and debtholders of the firm. However, this is inconsistent with other results in the literature, which suggest that part of the risk may be absorbed by other agents, such as tax authorities, and modified bargaining between employees and the firm. It is also inconsistent with empirical results which suggest that the link between pension risk and observed share prices may not be as direct as JMB assume. Also, it does not allow for regulation passing part of the risk onto customers of the firm. All of these will operate to attenuate the impact of pension risk on the observed equity beta. They will mean that the naïve version of the JMB adjustment will be too high and the resulting "pure" operating asset beta too low, precisely the effect which is observed.

It is effectively impossible to adapt the JMB method to give a robust method for estimating an adjustment which allows for all the above effects. The influence of each issue is very difficult to measure. In aggregate they present an almost impossible measurement problem. Given these difficulties, the only realistic approach would be to adopt a method based on direct empirical estimation of the effect of pension fund risk on measured asset betas. The key to this approach is determining the beta of the pension liabilities relative to the beta of the pension assets. Unfortunately, the empirical results in the literature do not pin down this assumption. Even if they did, they apply to unregulated firms and so do not answer the question of how regulation itself impacts the relationship between observed asset betas and the "pure" operating asset beta.

In practice, the most one can reliably say based on the JMB method is that all reasonable sets of assumptions give a result where the "pure" operating asset beta is no greater than the observed conventional asset beta. Therefore, the conventional asset beta may be used as an upper limit of the "pure" operating asset beta.

Given the difficulty of adjusting observed asset betas to give a "pure" operating asset beta, it leaves the question of how to estimate a "pure" operating asset beta, if one is required. There is also an issue as to how such an estimate should be used. If a "pure" operating asset beta is required the only robust way of estimating it would be to estimate an industry asset beta for a sample of companies similar to the regulated companies but which do not have DB pension plans. If the regulated company is unique, then this approach is not available and the matter would be almost entirely one of judgement.

Finally, there is the important issue of how a "pure" operating asset beta should be used. This measure applies to a hypothetical entity that does not have a DB pension plan. As discussed in

Section 3.3 above, the existence of a DB plan will affect the beta of the operations. Therefore, there is an issue of consistency. A cost of capital based on the "pure" operating asset beta must be applied to a set of cash flows and asset values which represent the same assumptions on which it is based. For instance, it would be inconsistent to estimate a cost of capital as if the firm has no pension fund and then apply this to a set of cash flows which include pension fund cash flows. It would be equally inconsistent to apply the "pure" operating cost of capital to a set of cash flows that were implicitly affected by the existence of a DB pension fund because, for instance, the cash flows reflect wage rates that were affected by the DB pension arrangement. Inconsistency in this regard could result either in double-counting or excessive strictness, depending on the nature of the inconsistency.

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